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These are the observed magnitudes, and will be on the same scale as those of the Cordoba D.M.

Mount Hamilton, California:
1895 *August* 29.

On the Extended Nebulosity about 15 *Monocerotis.*

By E. E. Barnard.

I am somewhat surprised at Dr. Roberts' statements in *Monthly Notices*, vol. lv. No. 7, for May 1895, where he condemns the idea of the diffused nebulosity shown about 15 *Monocerotis* on my photograph of 1894 February 1.

I must also object to the unjust comparison that he has made. He has shown upon the screen a lantern slide made from my glass positive of this region, which is in the possession of the R.A.S. This he has enlarged some four or five times to compare with his *unenlarged* photograph. He finds under these conditions that my picture is coarse, and that the nebulosity to which I called attention is not real, but is due to diffused light from many small stars.

I would say that these pictures, made with a short focus lens, are not intended to be enlarged, or, if so, but slightly. If the subjects are wanted on a larger scale the best plan is to use a longer focus and bigger telescope for that purpose—such, for instance, as Dr. Roberts' reflector.

They are intended to be looked at and studied as *pictures* of the regions they show, and are not to be examined microscopically. It is unjust to use an enlargement such as Dr. Roberts used, because it necessarily puts these pictures at a disadvantage. My picture was simply spoiled by this, while Dr. Roberts retained its original qualities, not being enlarged.

An enlargement should not be made from a copy, but from the original, because a copy like this was made with special reference to showing the nebulosity; the stars therefore suffer, especially if an enlargement is made.

A short focus lens like this is not intended to show small details because of its small scale. The study of small details belongs specially to large telescopes. The short focus lens, however, is exceptionally fine for just such large diffused nebulosities as that surrounding 15 *Monocerotis.*

Dr. Roberts seems to forget, in speaking of my paper in *Astronomy and Astro-Physics*, vol. xiii. pp. 178–182, that it was I who called his attention to the fact that 15 *Monocerotis* was really nebulous, and that the closer nebulosities about this star were the special province of larger telescopes than mine.

I shall quote from the article in *Astronomy and Astro-Physics*:—

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"Another photograph of the region about 15 *Monocerotis* on February 1, 1894, with three hours' exposure, shows the great nebula that envelopes 15 *Monocerotis* very much better than the previous picture. Its full extent—in diameter—can be taken roughly at 3°. It clusters densely about the groups of stars and then spreads out in a weak, diffuse light with rifts in it and irregularly terminated along the edges of a vast vacancy in the Milky Way. The condensation, which is very strong, is not at 15 *Monocerotis*, but 12′ south preceding that star, where it becomes a compact mass, with numerous wisps and holes in it. The whole group of three or four bright stars are involved in this denser wispy light, but 15 *Monocerotis* itself does not seem to be specially connected with the nebulosity further than to be apparently in it—that is, there are no indications of condensation about this the brightest star of the group. *This remarkable nebula—the denser part of it—is worthy of study with a more powerful photographic telescope. The condensed part of the nebula is only a few minutes in diameter, but it would readily photograph in a large instrument.* The place of 15 *Monocerotis* for 1860·0 is

$$\alpha = 6^{\mathrm{h}}\ 33^{\mathrm{m}}\ 16^{\mathrm{s}} + 10^{\circ}\ 1'{\cdot}3.$$

It is thus described in the catalogue (N.G.C.) '15 *Monoc.* Cl.$^{*}_{*}$, ? neb.'"

It will be seen by the italicised portion of this description that I was fully aware of the inability of the Willard lens to deal with the closer details of this nebula, and I suppose this really called Dr. Roberts' attention to the object.

The glass positive I sent to the R.A.S. does not show the details of this nebula close to 15 *Monocerotis*, though much detail is shown on the original negative, because, as I have said, my aim was to show the diffused nebulosity, which required a different treatment.

I forward to the Society three paper prints from an enlargement from the original negative. These pictures are printed to different depths to show the diffused nebulosity.

Dr. Roberts states that "there are vast areas on the camera plate photographed, which, to most of us, would be accepted as evidence of nebulosity with dark tortuous rifts in it, but it is not nebulosity at all. It is, in fact, the effect of the diffused light of numerous and close stars being concentrated upon the photo-film by a small instrument, and the dark rifts are only areas with fewer stars in them, by causing the appearance that the crowded star areas are involved in true nebulosity." It will be noticed that this statement cannot strictly hold in the face of the facts shown by these prints.

By examining these pictures I send, it will be seen that Dr. Roberts' reasoning is decidedly wrong.

This diffused light is in nowise confined to the star areas. It will be also readily seen that it spreads over a large region where

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there are essentially no stars at all—even where Dr. Roberts' reflector can show no stars.

That this is real diffused nebulosity there is no reason whatever to doubt. The photograph shows that it begins gradually to diffuse from 15 *Monocerotis* and spreads out over a large region covering star areas and vacancies for some degrees. I think an unprejudiced inspection of these prints will prove these statements.

As a further proof that this cannot be nebulosity which his 20-inch fails to show, Dr. Roberts says his photograph shows faint stars not on my positive, though the exposure was the same.

This proof is a rather surprising one. So far as the stars are concerned, Dr. Roberts gets the full effect of the light area of a 20 inch over that of a 6-inch. It is not at all unreasonable, therefore, that he should get fainter stars than I do in the same time, for the relative light areas are as 36 to 400, the quantity of light in his case being some eleven times greater.

But when it comes to nebulous areas quite a different condition prevails, and this I do not think will follow any special law of aperture and focus.

I should expect by all means to photograph large diffused nebulous masses quicker and better with the Willard lens than with a 20-inch reflector, though the reflector ought certainly to show fainter stars.

As an illustration of this matter of photographing large diffused areas of feeble light I would refer to some photographs made with a very small lens of $1\frac{1}{2}$ inch diameter. Compared with the Willard lens the light ratio of this small lens is about $\frac{1}{3\cdot5}$ to $\frac{1}{5}$. Instead of the smaller lens being some two times as quick on large faint areas of light, it is really upwards of fifteen or twenty times as quick, if we are to take the testimony of actual work made for the past year.

But I cannot see that there is any special reason to contest for the existence of this nebulosity, for we find similar areas of nebulosity elsewhere in the Milky Way that have passed unquestioned.

In conclusion let me add that both the Willard lens and Dr. Roberts' reflector have each their special field, which in nowise conflict, but in which they mutually supplement each other for the benefit and advancement of truth and knowledge.

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